ntroduction to the Philosophy of Light. Parts 3-4

A Message of Light

Containing a Scientific Foundation for Religion

Floyd Irving Lorbeer

INTRODUCTION TO

The Philosophy of Light

PART III.

CONTAINING THE ELECTRICAL HYPOTHESIS OF MIND.

FLOYD IRVING LORBEER, B.D.

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Gift of

Floyd Irving Lorbeer

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REVERIE.

I know there shall dawn a day
    Is it here on homely earth?
Is it yonder, worlds away,
    Where the strange and new have birth,
That Power comes full in play?

Somewhere, below, above,
    Shall a day dawn—this I know—
When Power, which vainly strove
    My weakness to o'erthrow,
Shall triumph. I breath, I move,

I truly am, at last!
    For a veil is rent between
Me and the truth which passed
    Fitful, half-guessed, half seen,
Grasped at, not gained, held fast.

I for my race and me
    Shall apprehend life's law:
In the legend of man shall see
    Writ large what small I saw
In my life's tale; both agree.

As the record from youth to age
    Of my own, the single soul—
So the world's wide book; one page
    Deciphered explains the whole
Of our common heritage.

—*Robert Browning.*

FOREWORD.

IN Part I of our thesis we outlined certain general reasons for regarding the medium of a wave of light as the ultimate reality. We have called this medium which is commonly called "ether" by various names such as "The Light or Electric Field," "The Ocean of Light," or simply "Light." With this terminology much of the confusion that exists between the relation of a wave of light to its medium is done away for we can then say that just as the medium of a wave of water is water and the medium of a vibration of air is air so the medium of a wave of light is light.

In Part II of our thesis we outlined the data upon which science rests the electrical or luminous unity of the external world.

In Part III we turn to certain physiological and psychological phenomena which lead us to conclude that nerve conduction and mental processes are also electrical or luminous.

CHAPTER I.

The Electrical Nature of Nerve Conduction.

The electrical discoveries of the latter part of the nineteenth century and the opening decade of the twentieth century have fairly well established the electrical unity of the external world. But is the inner world of sense impressions and mental activity also electrical or luminous in substance? In order to seek to answer this question we first examine the nerve currents by means of which impressions from the outer world reach the mind. Such an examination shows that an enormous amount of study has been given to the anatomy and physiology of the nerves. As a result of such a study it early became apparent that nerve activity resembled electrical activity and an electrical theory of nerve conduction was put forward. Such a theory has had an up and down career as new discoveries have been made and, while it is still opposed by some, it is now regarded by many as the most plausible explanation of nerve conduction.

What, then, are the grounds for such a conception?

1. In the first place the structure of the nerve resembles that used for electrical conduction. David Fraser Harris in his volume "Nerves" of the Home University Library series says, "The great majority of nerves are those called medullated, those provided with an insulating sheath, a fatty substance which in life is of semi-solid consistency. This fatty substance may be regarded as an

insulator surrounding a central core or axis, a most delicate thread which takes its origin in a nerve cell somewhere. The medullated nerve-fibre is therefore a minute cylinder of fatty sheath surrounding the true conducting substance, and it resembles, in some respects, an electrical wire inside its insulator. The central core which conducts the nerve impulses answers to the wire itself, the fatty sheath corresponds to the insulating cover of cotton, silk, or gutta-percha, or the like. A large number of these fibres are bound up together to form a nerve-trunk exactly as a large number of wires are placed together to form a cable." [1]

2. In the second place, an electric change is the one certain token of a nervous impulse. In 1843 Du Bois-Reymond one of the pioneers in "electrophysiology" found what he considered direct experimental proof of the existence of electrical currents in the nerves. It had, of course, been previously conjectured that nerve-commotion is a phase of electricity. But this experimenter discovered that, if we cut a nerve and then apply an electrometer to it, the cross section is negative toward the longitudinal surface of the nerve."

Ladd and Woodworth say, "In the absence of mechanical, thermal, or chemical manifestations of the nerve impulse, we should be wholly at a loss regarding its physical nature, were it not for the fact that there is an electrical manifestation, in the "current of action," to which reference has already several times been made. If a nerve is excited by any means at one point, and if the poles of a galvanometer or capillary electrometer are laid on a distant part of the nerve, every excitation of the nerve is followed by a swing of the galvanometer needle, or by a movement of the mercury in the electrometer—thus indicating the existence of an electrical current in the nerve itself. The rate at which this electrical disturbance travels along the nerve is the same as the speed of the nerve-impulse. Such a current of action is, indeed, not peculiar to the nerve; it occurs in muscles, glands, the retina, and apparently in all active living tissues. In most of these cases, there are other manifestations of activity, and the current of action is usually regarded as a mere by-product. But since the nerve shows no other manifestation the suggestion has been made by several physiologists that there is no other process; but that the nerve-impulse is *essentially* an electrical disturbance moving along the nerve."[2]

Sir Michael Foster says, "Beyond the terminal results such as muscular contraction in the case of a nerve going to a muscle, or some affectation of the central nervous system in the case of a nerve still in connection with its nervous center, there is one event and one event only which we are able to recognize as the objective token of a nervous impulse, and that is an electric change."[3]

3. Again, just as the current of electricity on a wire varies according to the length and cross section of the wire so does the nerve current. In speaking of the current flowing in the nerve Ladd says, "Its electro-motive force is greater, the larger and thicker the nerve."[4] Ladd also says, "The electrotonic effect of the constant current upon the nerve, like its direct excitatory effect, is influenced by the strength of the current, by its direction, its making and breaking, and by the length of the nerve through which the current flows."[5]

4. Changes of temperature also affect the nerve current

in accordance with electrical principles. With metals the resistance to an electric current increases as the temperature rises, but with liquids, carbons, and a few alloys, the resistance decreases as the temperature rises. In the case of nerve conduction, which, of course, is non-metallic, the resistance, within certain limits, decreases as the temperature rises; while in all cases it is evident that temperature affects the conductance. D. F. Harris says, "While in frogs' nerves the velocity of conduction is thirty metres a second at 17 degrees centigrade, it is as much as sixty-five at 35 degrees C., or more than twice as fast."[6] Nerve conduction is also much slower in cold blooded than in warm blooded animals.

Conversely, just as electrical action produces an increase of temperature so nervous excitation seems to produce an increase of temperature in nerve centers. Ladd says, "Nervous excitation appears to produce a perceptible change of temperature in the centers of the brain; and this change can scarcely be due to increased flow of arterial blood."[7]

5. The nerve current also travels with a uniform rate of speed in the nerve trunks as does an electric current in a substance of uniform character. Sherrington, the English Psysiologist, who is regarded by many as the best authority on the subject of nerve conduction says, "In the nerve-trunks the interval between the amount of stimulation and the appearance of response (electrical) at any distant point is strictly proportional to the distance of that point from the seat of stimulation."[8]

6. As in the case of well known electrical phenomena, nerve action also shows a definite relation between stimulus and effect. Professor Sherrington in speaking of the nerve

trunk says, "The accuracy of grading within a certain range of stimulus-intensity is so remarkable that the ratio between stimulus-intensity and response-intensity has by some observers been assigned to mathematical expression." In speaking of action in the reflex-arcs Professor Sherrington further says, "The increments of the reflex run fairly steadily with the up-gradient of stimulus."[9]

7. Nerve impulses also reinforce or augment each other in a similar manner to electric impulses. Exner's experiments have shown that nerve stimuli applied together in point of time to the fore limb region of a rabbits cortex and to the skin of the crossed foot, exert a facilitating influence on each other. Again, a sound conveyed to the ear of a chloralized rabbit increases the amplitude of a reflex movement of the foot, induced by a stimulus applied to the foot a moment later.

8. Nerve impulses may interfere with each other in a similar manner to electric impulses. Electric currents often have a decided affect upon each other as is illustrated by the effect of a high power current in the close neighborhood of a telephone wire. So also with nerve action. The stimulus of a bright light together with a loud noise is much more apt to confuse either animal or man than if one sense alone is affected. Also a bright light will interfere with the observation of a less bright one, or a strong taste of pepper will prevent one from noticing other tastes that otherwise could easily be recognized.

9. Nerve currents like electric currents also appear to follow the path of least resistance. Pillsbury, in speaking of nerve action and its relation to the synapse says, "The synapse governs the course of the impulse. Each sensory

path makes connections with several motor and associative paths or neurones and any impulse will take the path that offers the least resistance."[10] Most modern conceptions of habit and memory association proceed upon the principle that nerve currents take the path of least resistance.

10. Again, nerve currents diffuse in a way similar to electric action. Bain stated the Law of Diffusion as follows, "According as an impression is accompanied with feeling, the aroused currents diffuse themselves over the brain leading to a general agitation of the moving organs, as well as affecting the viscera." William James, who quotes the above, says, "We have now experimental proof that the heart-beats, the arterial pressure, the respiration, the sweat glands, the pupil, the bladder, bowels, and uterus, as well as the voluntary muscles, may have their tone and degree of contraction altered even by the most insignificant sensorial stimuli. In short, *a process set up anywhere in the centres reverberates everywhere, and in some way or other affects the organism throughout, making its activities either greater or less.* It is as if the nerve-central mass were like a good conductor charged with electricity, of which the tension cannot be changed at all without changing it everywhere at once."[11]

William James puts the next to the last sentence of the above quotation in italics but, as indicating the similarity of nervous diffusion and electric diffusion, the italics could well be continued to the end of the quotation. William James saw that the two phenomena were similar. We believe that the evidence shows that we can go further and say that both nervous and electrical diffusion act in the same way because both are electrical and conform to the same laws.

11. Finally, the speed of the nerve current is not incompatible with electrical principles. Many scientists who at first thought that nervous impulses were electrical abandoned the idea when the speed of the nerve impulse was made known. For the electrical current on a copper wire may have a velocity of as much as 186,000 miles a second while the nerve current has a velocity of less than 200 feet per second. But those who abandoned the electrical conception of nerve currents on the ground of the difference in speed appear to have been too hasty for we know now that the speed of electrical propagation is determined by the medium of propagation and its resistance etc. When these factors are taken into consideration the speed of propagation of a nerve impulse and of an electric current under similar conditions is not incompatible. For instance, according to Ladd, the resistance of the nerve is about 50,000,000 times that of the copper wire.[12]

Furthermore, that the velocity of the nervous impulse is not incompatible with the electric current under similar conditions has been demonstrated by laboratory experiment. An electrical apparatus has been devised that conforms very closely to the action of the nerve. This is known as a "core conductor." In speaking of this apparatus, Ladd and Woodworth in their "Elements of Physiological Psychology" say, "The electrical state may be generated in the nerve by various sorts of stimuli. In the core model also, the electric wave can be imitated by a mechanical 'stimulus' as well as by an electrical; and this fact rather strengthens the analogy between the nerve and the core conductor. The rate of propagation of the electric wave, in a core conductor, varies according to the materials of which it is constructed; but it may be as low as 100 metres per second, and this is not incompatible with the speed of transmission in nerve. The fact that electricity travels along a wire between the poles of a battery or dynamo at an infinitely faster rate is therefore no disproof, as was formerly held, of the view that the nerve impulse is essentially electrical."[13]

The data which indicate that the nerve current is essentially an electrical current may then be summarized as follows:—

1. The structure of the nerve resembles that used for electrical conduction.

2. An electrical change is the one certain indication of a nervous impulse.

3. The nerve current varies according to the length and cross section of the nerve in a similar way to the electric current.

4. It varies with temperature like an electric current.

5. It travels with a uniform rate of speed.

6. There is a definite relation between stimulus and effect.

7. Nerve currents may reenforce each other as do electric currents.

8. They may interfere with each other.

9. They appear to follow the path of least resistance.

10. They diffuse in a way similar to electric action.

11. The velocity of the nerve current conforms to electrical principles.

Having outlined some of the evidence for regarding nerve conduction as essentially electrical we turn for a moment to compare the electrical conception with a rival theory namely that nerve conduction is chemical action.

Alexander Bain in "The Senses and the Intellect" says, "A nerve impulse gives rise to no chemical or thermal change that present methods can detect."

Sherrington says, "Against the likelihood of nervous conduction being pre-eminently a chemical rather than a physical process must be reckoned as MacDonald well urges, its speed of propagation, its brevity of time relations, its freedom from perceptible temperature change, its facile excitation by mechanical means, its facilitation by cold, etc."[14]

Ladd and Woodworth say, "By analogy with other living tissues, the activity of a nerve is readily thought of as a chemical process. It might be likened in a measure to the setting off of a train of gunpowder or of a fuse, in which the oxidation of one part acts to unite the next. The simile would halt, since the fuse is burnt out in its activity, while the nerve remains in good condition and ready for further activity. A comparison with other living tissues, such as the muscle is more appropriate. The muscle, after one contraction, remains in good condition, and yet oxidation has gone on in the muscle; explosive material has been consumed; in a word, catabolism has occured in the active tissue. . . . .

"If the activity of the nerve is like other chemical and catabolic processes, it should give rise to the waste products of catabolism, even as the muscle gives rise to carbon dioxide, lactic acid, etc. With this in view physiologists have looked for the carbon dioxide produced by nerve action, but the most delicate tests have been unable to detect any. They have looked for the acid reaction which would betray catabolism, but they have got no clear evidence of the production of acid products.

They have looked for the heat which is evolved in all known instances of oxidation, and have applied instruments capable of detecting a rise in temperature of 1/5000 of a degree centigrade, but have not been able to detect the slightest production of heat. These negative results impress different physiologists differently. Some conclude that the activity of the nerve is, after all, not a chemical process, or at least not a process involving catabolism. Others are still confident that there is catabolism there, only that it is too slight for our present means of detection."[15]

Ladd and Woodworth conclude their comparison of the chemical and electrical theories as follows:—"While, then, certain competent authorities still oppose this theory (the electric theory) it must be admitted that it accounts for more of the very puzzling phenomena than do any other of the present theories of conduction in the nerves. It may, then, properly serve as a hypothesis about which to gather the principle facts of the physiology of nerves. At any rate, the only rival view, at the moment, seems to be a chemical theory, which must either controvert the doct ine of the conservation of energy, or else admit such an amazing ability for promptness and completeness of metabolism as is difficult to imagine. To suppose the nerve-fibre capable of instantaneously recombining without any detectable loss of energy, the elements which have been separated by the work done through hours of continuous functioning, is to convert it into a wonderful kind of laboratory."

Of course, if we make certain definitions of chemical action, then it is possible to harmonize the chemical and electrical conceptions of nervous action for chemical and electrical action cannot be wholly separated. Indeed as good an authority as Michael Faraday has said, "The forces called electricity and chemical action are one and the same." If this identification is made, then, any argument that nerve conduction is chemical rather than electrical becomes absurd for it would be like arguing that a sparrow is not a bird because it is a feathered creature. But the present tendency is to regard chemical action as dealing with changes in the constitution of the molecule while electrical action is regarded as dealing with movements of electrons. Sir Humphrey Davy as early as 1810 said, "Electrical and chemical attractions are produced by the same cause acting in the one case on particles, and in the other on masses." J. W. Mellor, in "Modern Inorganic Chemistry," in speaking of radio-activity says, "If chemistry be confined to the study of phenomena with the atom as unit, radioactivity regarded as an infra-atomic phenomenon is a kind of meta-chemistry."[16]

If, then, we confine chemical action to include only action in which the atom is the unit there seems to be little if any evidence that chemical action takes place in connection with nerve conductance. But even if it could be shown that some chemical action does take place this would not disprove the electrical nature of the nerve impulse. It would only show that both kinds of action take place.

In view then, of the negative evidence for the theory that nerve conductance is chemical action together with the many positive evidences of electrical action as outlined in this chapter we conclude that nerve conduction is essentially a kind of electrical phenomena.

This does not mean that the nerve current is precisely like an electrical current on a copper wire. Certain living and vital conditions may well enter into the nerve current as many have pointed out, but it does mean that the nerve current in its action and affects so conforms to electrical principles that it may well be considered as essentially electrical.

CHAPTER II.

The Electrical Hypothesis of Mind.

In this chapter we propose the hypothesis that mental activity conforms to electrical principles and shall outline some of the evidence for such a position.

Today as never before we realize how closely bound together are physiology and psychology or nerve and brain structure with mental activity. Joseph Le Conte in "Evolution and its Relation to Religious Thought," has stated the results of physiological investigations up to his day very clearly. On page 308 of this book he says: "Physiologists have established the correlation of vital with chemical and physical forces and probably in some sense, at least, of mental with vital forces. They have proved, in every act of perception, first a physical change in a nerve-terminal, then a propagated thrill along a nerve-fibre, and then a resulting change, physical or chemical, in the brain; and in every act of volition, a change first in the brain-cell, then a return thrill along a nerve-fibre, and a resulting contraction of a muscle. Even the velocity of the transmission to and fro has been measured, and the time necessary to produce brain-changes established. They have also established the existence of physical and chemical changes in the brain corresponding to every change of mental state, and with great probability an exact quantitative relation between these changes of brain and the corresponding changes of mind."

In the light of this kind of evidence and much other of a similar nature showing the closeness of relation between brain and mind many have swung to a decidedly atomistic or materialistic conception of consciousness. Others cling to an immaterial conception of mind. The Philosophy of Light, in a certain sense, holds a middle ground. But it will help us to get the bearing of the electrical hypothesis of mind if at the start we state the two well known types of theory of mind which are currently held together with the electrical one.

They are:

I. All mental states or states of consciousness are identified with or inseparable from brain and nerve cells and when the brain disintegrates all consciousness and personality vanish with such disintegration. "As the liver secretes bile so does the brain secrete thought." "Thought is nothing more than a function of the substances of which the brain is composed." This kind of a conception together with the philosophy connected with it is frequently spoken of by its opponents as gross materialism.

II. The second theory is that brain and mind are two quite different things. The former is material and the latter immaterial. We shall refer to this theory as the immaterial theory of mind.

III. The electrical theory may be stated as follows:

Brain is atomic but mind is electrical. Mental activity or thought is inseparable from a luminous or electrical substance. The electrical substance of thought is most intimately associated with atomic cells yet is distinct from the atomic condition. It may be regarded as a higher order or freer condition of substance than brain cells.

We shall refer to this theory as the electrical or luminous theory of mind.

We shall not go any further than is necessary into the age long controversy between the so called materialists on the one hand and the so called immaterialists or spiritualists on the other. Much of the controversy hinges upon definitions and the electrical discoveries of the twentieth century have radically changed our definitions of matter while some physicists are uncertain whether to call electricity material or immaterial. We shall use the positive term believing that consistency as well as many other considerations requires such usage.

Those who hold that mind is inseparable from brain cells do so on the basis of the closeness of interaction between brain and mental states and upon the marked effects upon consciousness of physical causes such as injuries, narcotics, drugs, temperature, blood pressure, food, air, etc. Those who hold it also often point to the absurdities of the immaterial theory as controverting the doctrine of the conservation of energy etc.

On the other hand those who hold the immaterial conception of mind point out the many differences between the action of brain and mind and then argue somewhat as follows:

Brain and mind are different.
Brain is material.
Therefore mind is immaterial.

But, even tho brain and mind are different, the fact of difference does not warrant the conclusion that mind is immaterial. Water and air are different. Water is material. But it does not follow that air is immaterial. The immaterial theory also raises all kinds of unanswerable questions about the relation and interaction between the material and the immaterial. Nevertheless, the immaterial theory has a large following and has very frequently been the means of attempting to explain the unknown so it must be given adequate consideration.

In contrast to both the material and immaterial conception of mind the electrical hypothesis gives us, in the first place, a positive term to work with. It permits of an exceedingly close relation between brain and mind and, at the same time, allows for the differences that appear to exist. It also does not controvert the doctrine of the conservation of energy and does not raise the problems of the relationship between two kinds of realms assumed to be radically different. It also, at least, leaves fully open the possibility of personal immortality.

With these three theories in mind then, we turn to physiology and psychology to examine some important phases of mental phenomena and to enquire as to which theory they best fit and which theory furnishes the most plausible explanation of the phenomena.

1. In the first place we note that both physiologists and psychologists frequently compare the action of brain centers with electricity.

Nathan Oppenheim, M.D. in "Mental Control and Growth" says, "We know that nerve-fibres are the means for conducting energy, and that the impulse finds its way to the surface cells of the brain. These paths to and from the brain have been beautifully demonstrated, so that absolutely no doubt remains about the course which impressions, made from without, take in the process of being recognized. Equally well we have come to possess considerable knowledge of the so-called centres, areas which when stimulated give rise to certain constant effects. These centres may be compared to the ordinary central stations, of which there may be an indefinitely large number, in the telephone system of a great city. Each 'central' serves a certain number of subscribers, who can be put in communication with any other subscribers only through their own 'central.' That is just like the arrangement in our brains and bodies."

Thomas Smith Glouston, M.D., LL.D., Lecturer on Mental Diseases at the University of Edinburgh, in "Hygiene of the Mind" says, "The nearest analogy to the working of a nerve cell is a small electric battery. . . . The cell, through its internal action, evolves nerve force and sends it out through the attached fibres as the battery evolves electricity and sends it out. Mind may be regarded as the highest form of nerve force. It is not 'created' by the brain but it is conditioned by that organ."

Such comparisons could be multiplied almost indefinitely.

2. We next ask what theory gives us the most plausible conception of the relation of the incoming and outgoing nerve currents to consciousness. As we have seen, every sense impression involves a flow of nerve current to the nerve and brain centers. Likewise every muscular act involves a flow from the center outward.

If we hold that mind is inseparable from atomic brain cells then we must also hold that every ingoing nerve current causes a chemical change in atomic cells. Likewise when brain cells wish to act they must set up some kind of current to produce the action.

On the other hand, if we hold that mind is immaterial then we must also hold that nerve currents produce a change in the immaterial stuff, and, when the immaterial stuff wishes to perform a muscular action it must ask something to produce a nerve current so that it can act. In other words those who hold that mind is immaterial must also hold that every perception involves a change from the material to the immaterial and every conscious action involves the reverse process.

In contrast to the above, if we hold that mind is inseparable from a non-atomic electrical or luminous substance, then, in the case of incoming and outgoing nerve currents we do not need to make explanations in the form of chemical changes of atoms nor of changes in an immaterial stuff. For the third theory involves no such changes but indicates that the nerve currents retain their electrical nature after they reach the brain centers.

If nerve currents are electrical and mind is atomic as the first theory requires then we would also have the peculiar situation of an atomic structure which is less active and free than an electrical substance getting its knowledge and performing its acts by means of a freer and finer condition of substance than itself. But if the substance of both mind and nerve currents is electrical then the substance of mind is at least as unlimited and high in its activity and freedom as are the nerve currents.

3. Again, the relation of the size and structure of the brain to mental power and intelligence must be taken into consideration. Physiologists tell us that intelligence is not to be judged on the basis of mere size and weight of

brain but rather on the basis largely of the complexity of brain structure and the number of connections made between cells. Which theory best fits this phase of the subject?

If we hold that cousciousness is confined to brain cells, then, What is the purpose of a growing number of connections between cells? and, What is it that communicates by means of the cell connections? and, If there is something that communicates by means of the cell connections, is not that something higher or different from brain cells? In the circulatory system of the blood the existence of capillaries indicates that there is something that makes use of the capillaries. Does not the existence of nerve connections indicate that there is also some kind of a substance that makes use of the nerve connections?

On the other hand, if our mind is immaterial, What is the need and necessity of having such connections and why should there be any relation between complexity of brain connections and mentality? The immaterial theory of mind thus seems to throw no light whatsoever upon the relation of brain structure and nerve connections to mental growth and intellectual powers.

But if we hold that mind is inseparable from a luminous or electrical substance, then it follows that the nerve connections serve a very definite and important purpose in coordinating and integrating the various incoming and outgoing nerve currents as well as furnishing a network of intercommunication and hence that memory and judgement and the ability to compare many things are dependent upon nerve connections just as psychologists tell us. Furthermore every electrician knows that the size and strength of a battery does not necessarily indicate the power of the battery but rather that the kind and nature of the connections are of far greater importance in estimating the strength of the battery than is size alone. This is just what we find to be true in the case of the mind of man.

The complexity of organization of brain and nerve connections as a criteria of mental strength and intelligence thus also appears to support the electrical or luminous theory of mind far more than it does the brain cell or the immaterial theory.

4. The effect of injuries upon memory also enters into the problem. Injuries frequently cause a partial and sometimes a total loss of memory. Such losses are sometimes not restored as far as we know and then again they sometimes are restored.

Take for example the case reported in the *Literary Digest* of March 19, 1921. An Australian soldier, already suffering from shell-shock, received a severe fright. As a result, the whole of his adult personality disappeared, and he became an infant—the mind of an infant in the body of a man. He could not talk properly, he could not walk properly, and most amazing of all, he could not take any food but milk. Gradually he grew up again, retracing in a year the mental development of a lifetime, and on returning to his native country, has become, it appears, a normal adult again.

The brain cell theory of memory could account for the loss of memory and loss of ability to act in such cases by saying that when brain cells are injured memories involved in such cells are also injured or destroyed. But the brain cell theory does not explain the restoration, for sometimes complete restoration has come almost instantly after many years of lapsed memory. Furthermore memory is frequently restored after certain brain cells have been completely destroyed.

On the other hand, the fact that injuries to the brain do cause a loss of memory is one of the strongest arguments against an immaterial theory of mind, for, if mind is immaterial, how can material injuries affect it?

But a theory of mental activity which regards memory as inseparable from a luminous or electrical substance which is closely related to brain cells yet not identical with them appears to offer a much more complete explanation. The explanation in the latter case proceeds along the line of saying that memory depends upon connections being properly established and when connections are broken or impared then memory will be impared and when connections are properly reestablished then memory will be restored. Just as the circulation of the blood is dependent upon arteries and veins and capillaries yet is not identical with them so mental activity while closely associated with nerve and brain structure is not to be identified with them. When arteries and veins are injured the circulation will be impared; likewise when brain cells are injured thought will be impared. But arteries are not blood and neither are brain cells the substance of thought.

That memory depends upon proper connections being established is the view of modern psychologists and the electrical conception of mind thus accords with such a view.

5. The affect of anaesthetics upon consciousness is another closely related field of study. Anaesthetics produce a gradual "sinking" of consciousness as well as a

gradual awakening and the sinking and awakening can be well regulated.

Herbert C. Crouch, Anaesthetist and Teacher of Anaesthetics at the St. Thomas's Samaritan and French Hospitals, London, in his article on anaesthetics in the Encyclopedia Britanica, eleventh edition, says, "The introduction by inhalation of any of the above drugs (chlorophorm and ether) into the organism produces an anaesthesia, the degree of which at any moment varies directly as the amount or tension of the vapour in the blood, and therefore also as the tension of the vapour in the inspired air. The organism in this case may be compared to an electric lamp, of which the voltage is, say 100; a current of less voltage will produce only a red heat, however many amperes are forced through; with the voltage at 100 the filiment will be white hot, at over 100 the filiment will fuse. So with these drugs: with the vapour at a low tension a certain low depth of anaesthesia is obtained; if the administrator increases the tension, true surgical anaesthesia is produced; if he increases it again, the filiment fuses and the patient dies. This is the principle which guides the anaesthetist; it is the quality of the vapour that decides the depth of the anaesthesia, not the quantity. An infinite quantity of chlorophorm may be absorbed with impunity if the tension be low, but a few drops will kill if the tension be high."

Now if consciousness is inseparable from atomic brain cells which are affected by the anesthetic then it appears difficult to explain how consciousness can be restored following the taking of an anesthetic but if anesthetics affect atomic matter in the way of breaking connections or of making connections more difficult then an explanation of the restoration of consciousness appears more plausible for it is well known that certain drugs decidedly affect the flow of a current on a wire and when such drugs are removed the current is restored. The fact also that the degree of anesthesia depends upon the quality rather than the quantity of the anesthetic tends also to cause us to think that the affect on the mind and nerve currents is more electrical than chemical.

On the other hand, the immaterial theory of mind does not appear to offer any aid in explaining the action of anaesthetics. If mind is immaterial why should anaesthetics affect it and what explanation can the immaterial theory offer of a gradual sinking and awakening of consciousness depending on the nature of the anaesthetic?

But if mental activity is itself electrical, then the comparison of the organism with electric phenomona which Dr. Crouch makes fits the situation in a way in which neither of the other theories of mental activity do. So once more the electrical conception of mental activity appears to offer an explanation that best conforms to the known facts.

6. Another large field of inquiry is that of the laws of habit. William James in his well known chapter on habit says, "The moment one tries to define what habit is one is led to the fundamental properties of matter. The laws of Nature are nothing but the immutable habits which the different elementary sorts of matter follow in their actions and reactions upon each other . . . The philosophy of habit is thus, in the first instance, a chapter in physics rather than in physiology or psychology. That it is at bottom a physical principle is admitted by all good writers on the subject."[18]

M. Leon Dumont, who has written, according to James, perhaps the most philosophical treatment on the subject of habit says, "Water, in flowing, hollows out for itself a channel, which grows broader and deeper, and, after having ceased to flow, it resumes, when it flows again, the same path traced by itself before. Just so, the impressions of the outer objects fashion for themselves in the nervous system more and more appropriate paths, and these vital phenomena recur under similar excitement from without, when they have been interrupted a certain time."

In his chapter on habit James also says "An acquired habit, from the physiological point of view, is nothing but a new pathway of discharge formed in the brain, by which certain incoming currents ever after tend to escape."

In another connection James says, "All the materials of our thought are due to the way in which one elementary process of the cerebral hemispheres tends to excite whatever other elementary process it may have excited at any former time. . . . In short, we may say, the amount of activity at any given point in the brain-cortex is the sum of the tendencies of all other points to discharge into it, such tendencies being proportionate (1) to the number of times the excitement of each other point may have accompanied that of the point in question; (2) to the intensity of such excitements; and (3) to the absence of any rival point functionally disconnected with the first point, into which the discharges might be diverted."[19]

What theory of habit and thought processes best conforms to such a description?

In the brain cell theory the analogy with water hardly holds for while the nerves are analogous with "channels" and "paths," there is nothing that is analogous with the water that forms such paths. And when we examine the question of "discharge" we are confronted with the further question, Discharge of what? The speed of thought does not permit us to conceive of an atomic substance that forms new paths and is discharged through them.

But when we compare the laws of habit with electrical principles we note first that just as the electrician compares the electrical current with the flow of water so does the psychologist in describing the laws of habit.

It is also evident that the general principle of habit formation accords with electrical principles for it is well known that after a current of electricity has been induced that thereafter the flow is facilitated.

Furthermore, the amount of activity or the sum of the tendencies which determine the processes of thought is stated by James in accord with electrical principles, in fact, again and again James uses the very language of the electrician in describing thought processes.

Electrical principles also apply to the action of the synapse to which many psychologists refer the formation of habit. Sherrington has made an extended study of this and has shown that electrical principles apply to the synapse as they do with the nerve fibres.

While then we have only touched upon the subject of habit still enough has been presented to indicate that electrical explanations accord with those of the psychologist as applied to the formation of habits.

7. The electrical conception of mental activity also appears to conform better than do other theories to the facts of both the differences and the closeness of interaction between the development of brain and mind.

Altho there are stages when the bodily organism and the mental powers seem to be parallel in their development yet there are other times when there are marked differences. Ladd and Woodworth have given us an excellent summary of the differences in development of the bodily organism and mental powers. We quote them in part.

"In spite of certain striking correspondences between the evolution of the bodily organism and the development of the mental powers, it must be held that there are marked divergences as well. At certain epochs of life the evolution of the brain seems to stand far in advance of the mind; at others, the mind appears to have overtaken and passed by the stage reached by its physical substratum. . . .

"For the first few weeks of infancy the embryonic relation between the relative development of the body and soul of the child seems to be maintained. Both are the subjects of rapid growth, but the former is still much in advance of the latter. The newly born infant is, in respect to the condition of its nervous system, much the most highly organized and fully equipped of all young animals; but as judged by the number and quality of its volutions and perceptions, many other young animals are less stupid.

"During the period of young manhood, or young womanhood, the dependence of the development of the mind on that of the body is most strikingly seen in the influence over the emotions and imagination from the sudden unfolding of certain bodily organs and powers. The indirect influence of these acts of feeling and imagination upon the more purely intellectual progress of the mind is of course, correspondingly great. But the dependence of mind on body is by no means such as to favor the view that there is no ground in a real being, other than the brain, for the order and rate of the mental development.

"This same statement is emphatically true of the long period of maturity which constitutes what we call the 'middle life' of man. During this time the nervous matter undergoes scarcely any discernable development. Nothing that microscope or electrometer can detect distinguishes the brain characteristic of the man of twenty-five from that of the man of fifty. A few grams of weight have perhaps been added to it during this long period of years . . . . Many minds, however, not only make vast acquisitions, but also experience a large unfolding of mental capacities during the period of middle life. How mature and wide-reaching do the judgments of some men then become! How profound the insight into the most abstract and difficult speculations comes to be! What cerebral evolution shall be conceived of as being the only true cause, and the exact physical correlate, of the mental development of Kant during the years preceding the appearance of the 'Critique of Pure Reason', or of Newton while he was unfolding the calculations and conjectures of the 'Principia'? To hold that the changing molecules of the brain substance of these thinkers were the sole subjects, really being and acting in the unrolling of these great dramas of human speculation, involves an astonishing credulity. . . .

"Advancing old age is doubtless, as a rule, characterized by a simultaneous decline both of certain mental and of certain bodily powers . . . . On the other hand, there are many cases, where no notable difference can be detected, or even fairly assumed, in the course of the psychical evolution down to the 'feebleness' of old age; where the course of mental development continues substantially undisturbed in all its most important features. The mind of the cultivated old man, with calm and broad judgment, with refined kindliness and fixed moral principles, is not to be spoken of as suffering a decline which keeps pace with the failing of his physical powers. It may justly be claimed that the final period of human life, on the whole, favors that theory which regards the mind as by no means wholly conditioned upon the brain for the character, order, and laws of its development."[20]

The above description seems to clearly indicate that there are marked differences between the development of brain and mind and any true conception of mind must take such differences into consideration.

The differences in develcpment would seem to furnish rather decisive argument against any atomic theory of mind as well as against any theory of parallel development. Differences in growth, differences in powers, difference in endurance, and differences in health all exist.

On the other hand the facts of difference do not warrant the banishing of the mind to an immaterial and unknown realm when there is a better known realm at hand which furnishes a basis for accounting for such differences.

Before our knowledge of electricity arose philosophers who examined the mind were right in realizing that mental action did not conform in many ways to bodily action and so were compelled to postulate some kind of a realm which was termed immaterial; but now a field has been uncovered which furnishes a more tangible basis for accounting for such differences. It would seem then both unscientific and unphilosophical to retain a realm which involves so many difficulties as does the assumption of an immaterial realm supposed to be outside the scrutiny of science.

The immaterial theory of mind fails to comform to the principal of the conservation of energy as known by science. It furnishes no basis for an understanding of how body and mind can interact and influence each other. It banishes the possibility of a scientific understanding of mental laws and development and, while attempting to account for the differences in development of body and mind, in reality furnishes no comprehensive basis for such differences.

In contrast to other theories the electrical conception of mind furnishes a plausible explanation for the differences in development of body and mind. At the same time it allows for a closeness of interaction. Chemically and physically we know that electrical action differs from atomic action yet there is frequently great closeness of interaction. In a similar way mind which is electrical in substance differs from brain cells which are atomic in structure. At the same time there must of necessity be an exceeding closeness of interaction between the two just as there is between the action of the heart and the blood flowing in it or the action of a motor and the current of electricity flowing in it.

The electrical hypothesis, then, offers an explanation of the differences in development of the bodily organism and mental powers and at the same time allows for great closeness of interaction.

8. Mental pathology such as "dissociation" or "multiple personality" constitutes another field of in-

vestigation. Such phenomena are frequently being explained by psychologists in such electrical terms as "broken connections." Thus W. B. Pillsbury says, "So far as present knowledge extends, it seems that the cause of the dissociation of the self is to be found in a disturbance of the connections between the experiences. The emotional shock breaks the associations between groups of cells, or cells that correspond to groups of memories. After the shock, an event in one group will recall other members of that group alone: the recall will not extend to the memories dependent upon the other group. Also, and more important for the explanation of the active self, the acts and thoughts and emotions will be controlled at any moment by the experiences that belong to one group; elements from the other group will have no effect upon action at the times the other group is dominant. The acts of the one self, or group of experiences, will be consistent, but the acts of one self will not be consistent with the acts of the other self, or group of experiences. That the qualities ordinarily attributed to the self disappear or are greatly modified when the connections between different experiences are broken, is strong proof that the self in the normal individual is largely determined in its character by the way the different experiences interact. This series of connections gives continuous memory, makes the experiences of any moment a unit, and through directing thought and act keeps the self of one moment consistent with the self of other moments."[21]

Neither atomic nor immaterial explanations seem to satisfy such a description. They furnish no help in the way of understanding how connections can be made and broken. But a comparison with electrical principles makes such phenomena plausible. For everyone is familiar in a general way with the method of electrical connections. The electrical conception of nerve connections also accords with the methods used to restore a better unity. For example the treatment in such cases is usually that of endeavoring to have the person retrace former associations and make new associations between items that apparently had been held apart and not connected or associated together. And it is found that the more connections established and associations made the better will be the unity of the person.

The electrical hypothesis of mental action thus accords with the explanations given by psychologists of dissociations as well as with the method used to gain a proper unity.

9. Finally, we know that the personality of all normal persons is a unity. But how can this unity exist side by side with an infinite variety of memory items or past sensations and be able to recall them when needed. Does it reach out for a past memory item as a man reaches for a letter in a pigeon hole? There may be some truth in such a reaching out for a memory item but the great difficulty with such a notion is to conceive how the central unity if it were not connected in some way with its former sense impressions knew that it had such and such a past sensation or memory item that was available. So it is evident that we must have a theory of mind and memory which fits the fact that every sense impression or sense charge which has become a part of consciousness is known in some way by the central unity and bound to it. This is a difficult relation to try to

imagine, nevertheless the electrical system of the atom is just such a system. For in the atom we have a system in which the central core is intimately bound up with the surrounding charges, in fact is composed of a positive charge which balances and equals the surrounding negative charges. Some such an electric relation may well be the relation that exists between the unity of man's personality and the infinite variety of his memory items.

After this brief survey of some phases of the field of mental phenomena let us sum up some of the evidence for the electrical hypothesis of mind.

1. The comparison of mental with electrical action is already in wide use by physiologists and psychologists.

2. The electrical theory of mind is more plausible than other theories in that it involves no chemical changes of nerve currents into atomic cells nor changes into an immaterial stuff. Since the incoming and outgoing nerve currents are electrical it is natural to expect that the centers should also be electrical. In the electrical theory the mind itself is in the highest condition of substance known.

3. The electrical conception of mind agrees with our knowledge that the complexity of structure and the number of connections between nerve cells are indications of mental power and intelligence.

4. It conforms to our knowledge of the affects of injuries upon consciousness. It furnishes a reason for the fact that memory impaired by injury is frequently restored when conditions have been restored.

5. It accords with our knowledge of the affects of anaesthetics upon consciousness and furnishes some kind of an explanation for the gradual sinking and awakening of consciousness following the taking of an anesthetic.

6. It conforms to the laws of habit and mental thinking and furnishes a basis for a better understanding of the laws of training and education.

7. It takes into consideration both the differences and the closeness of interaction between brain and mind and supplies a means for accounting for both.

8. It agrees with our knowledge of mental pathology and helps us to understand the cause and cure of such disorders.

9. It gives us a clue to an understanding of the unity of consciousness which unites together the vast variety of mental content.

Of course, it is obvious that the electrical hypothesis, does not solve all problems. But, if it pushes back the circle of man's darkness a little farther, then it is entitled to acceptance as a working hypothesis. Its acceptance as such an hypothesis merely blazes the trail to a larger understanding of the cosmos in which it is man's privilege to dwell and to ever explore.

It may be well, before we conclude, to state that even if the first theory of mind is true, even if consciousness is inseparable from atomic matter, this would not mean the rejection of the main proposition that Light is the ultimate reality for physics has shown that all atoms are composed of electrons which in turn are whirls of the ether or electrical field that fills all space.

But if thought and mind cannot be separated from atomic matter then it would seem that we must abandon the conception of personal immortality. But the evidence, we think, is on the side of concluding that mind is in the electrical condition and therefore that it may survive after atomic matter has become disintegrated.

In what large ways, then, are we helped by the proposition that mind is inseparable from a luminous or electrical substance?

The electrical conception enables us:—

1. To more clearly understand that consciousness and personality grow as naturally as any other process and that every sensation adds to our stream of consciousness and affects our personality.

2. To see that sense stimuli can affect our minds without having to jump across any gap from the material to the immaterial. So we can banish the mental agony involved in a material and immaterial dualism.

3. To realize that man as constituted now is best regarded as being in a certain sense dual in his nature consisting of body and mind, the former conforming in general to atomic action and the latter to electric action. And yet since atoms are formed of electrons both body and mind have their ultimate source in the Light Ocean.

4. To define the "objective" as an infinite variety of arrangement of electrons in the external world and "subjective" as the unity and sum total of all the individual's past light.

5. To hold to the possibility of a luminous entity, which psychology calls "mind" and which theology calls "soul," continuing to exist after the denser body and brain cells are disintegrated.

6. To realize better "What God and man is."

7. To better understand how the Infinite Father is continually revealing Himself to us and constantly leading us to new truth and more light.

REFERENCES.

1. Nerves, p. 31 f.
2. Elements of Physiological Psychology, p. 137 f.
3. Physiology, 5th edition, p. 123.
4. Outlines of Physiological Psychology, p. 130.
5. Outlines of Physiological Psychology, p. 138.
6. Nerves, p. 41
7. Outlines of Physiological Psychology, p. 130.
8. Integrative Action of the Nervous System, p. 19.
9. Integrative Action of the Nervous System, p. 70 f.
10. Essentials of Psychology, p. 49 f.
11. Psychology (Briefer Course), p. 371 f.
12. Outlines of Physiological Psychology p. 125.
13. Elements of Physiological Psychology, p. 140 f.
14. Integrative Action of the Nervous System, p. 17.
15. Elements of Physiological Psychology, p. 135 f.
16. Modern Inorganic Chemistry, p. 836.
17. Hygiene of the Mind, p. 18.
18. Psychology (Briefer Course), p. 133 f.
19. Psychology (Briefer Course), p. 257.
20. Elements of Physiological Psychology, pp. 657-662.
21. Essentials of Psychology, p. 353.